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Laboratory Services Division, Pest Program
Washington State Department of Agriculture

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1999 Western Washington Exotic Defoliator Parasitoid Survey

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Background

In recent years, insect surveys conducted by the Washington State Department of Agriculture (WSDA) and funded by the USDA Animal and Plant Health Inspection Service (APHIS) Cooperative Agricultural Pest Survey (CAPS) program have detected a number of exotic species of defoliating moth pests (Lepidoptera) in Western Washington State. Several of the exotic species finds represent first record of the pest in the United States, having migrated into Washington from adjacent areas of British Columbia, Canada, where they were likely first introduced into North America. In one case, the exotic pest detection was the first record for the species in North America.

Most of the new exotic pests were likely introduced into the region within the last 20 to 40 years and are now unfortunately well established here. Some may eventually impact diverse northwest economic and environmental interests, including commercial nurseries, row crops, fruit tree production, private and commercial landscape management, and industries which rely on healthy native plant communities such as timber and tourism. For almost all of the exotic newcomers, their modes of entry into North America are unknown.

Exotic plant pests found in Washington State since 1985, year found, and detection status include:

- **apple ermine moth** (*Yponomeuta malinellus* Zeller) – 1985, New to United States
- **apple tortrix** (*Archips fuscocupreanus* Walsingham) – 1995, New to North America
- **apple skeletonizer** (*Swammerdamia pellicaria* (Retz.) – 1994, New to United States
- **barred fruit tree tortrix** (*Pandemis cerasana* (Hubner)) – 1994, New to United States
- **cherry bark tortrix** (*Enarmonia formosana* Scopoli) – 1991, New to United States
- **cherry ermine moth** (*Yponomeuta padellus* L.) – 1993, New to United States
- **dark fruit tree tortrix** (*Pandemis heparana* (D & Schif)) – 1994, New to United States
- **European emerald** (*Hemithea aestivaria* (Hubner)) – 1995, New to United States
- **'golden' leaf roller** (*Croesia holmiana* (L.)) – 1994, New to United States
- **green budworm** (*Hedya nubiferana* (Haworth)) – 1994, New to Western U.S.
- **green pug moth** (*Chloroclystis rectangulata* (L.)) – 1994, New to Western U.S.
- **lesser budmoth** (*Recurvaria nanella* (Hübner)) – 1994, New to Western U.S.
- **oak skeletonizer** (*Carcina quercana* (Fabricius)) – 1997, New to United States
- **rose shoot borer** (*Notocelia rosacolana* Doubleday) – 1996, New to United States
- **straw-colored tortrix** (*Clepsis spectrana* (Treitschke)) – 1998, New to United States

Many of these new species were reared to adult from field collected larvae during several CAPS surveys and any parasitoids present were kept for future analysis. This survey is largely an analysis of that compiled parasitoid material. Parasitoid predation is a key factor in determining whether introduced exotic species become significant economic pests here.

1999 Project Objectives

1. **Identify parasitoids reared from identified exotic defoliator larvae.**
2. **Summarize parasitoid/host associations and determine parasitoid prevalence (e.g. percent parasitism observed).**

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Project Methods and Results

Parasitoid and Host Identification

Defoliating lepidopteran larvae and pupae were collected from various target areas in Western Washington and reared on either artificial diet or host plant foliage to emergence of the adult moth or parasitoid(s). Larvae or pupae were maintained in individual ½ ounce, 1 oz., or 3 oz. plastic cups to ensure association of reared material, and all shed larval skins, pupal cases, and cocoons were collected and curated with reared specimens for use in species identification. (For survey coverage and methods details, see LaGasa et.al. 1997, LaGasa and Boyd 1997, LaGasa et. al. 1998). In some cases, lepidopteran larvae were also photographed to provide additional information for identification.

Reared parasitoids were initially sorted to the family level (Braconidae or Ichneumonidae) and host defoliator species was determined when possible using curated remains. Identification of host species was largely a process of comparing structural morphology between unknown host remains and the shed remains curated with identified adult moths in the WSDA reference collection. In most cases, the shed larval head and prothoracic shield (behind the head) provided sufficient information to determine species. Larval head and shield morphological characters compared included; overall coloration and pigmentation patterns, presence and position of hairs (chaetotaxy), shape and configuration of simple eyes, and the shape and pigmentation of mandibles. In some cases identification of host to species was not possible and host information provided here is presented at the highest taxonomic level feasible (i.e. Pandmis sp., and Yponomeutidae sp.). If host remains were lost or unidentifiable, reared parasitoids were curated but not included in this summary.

Associated parasitoids were sent to identifier specialists contracted for the purposes of this survey. Braconidae specimens were identified by Dr. Michael J. Sharkey, at the University of Kentucky, and Ichneumonidae specimens were identified by Dr. David Wahl, at the American Entomological Institute.

Due to needed revisions in several large taxonomic groups of parasitoids and poorly known groups, not all parasitoids were identifiable to the species level. However, all specimens were identified to genus, and discrete species were sorted to designated species numbers (i.e. species 1, species 2, etc.).

Defoliator larvae collected and reared for identification and parasitoid analysis in WSDA surveys represented a cross section of larval sampling from many plants, although the majority were from apple trees. Apple was the exclusive host-target of 1994/1995 survey (LaGasa et. al. 1996)

Overall, defoliator species identified from reared adults included some of the exotic species listed in the background section of this report, as well as other exotic species long established here and a few native species. Parasitoids reared from historically introduced exotic and native defoliator species were also identified in this survey to detect exotic parasitoid species possibly introduced with the exotic defoliators.

A total of **261 parasitoid specimens** were identified in this survey, comprising **46 parasitoid species reared from 14 species of defoliator**.

At least **one exotic parasitoid species**, a European species not previously recorded in North America, was identified in this survey – ***Hormius radialis* Telenga** *(Braconidae: Hormiinae)* reared from a native defoliator, *Choristoneura rosaceana*, the oblique-banded leafroller.

Additionally, **one apparent undescribed species** was found in the reared material, a ***Charitopes n. sp.*** – D. Wahl det. (*Ichneumonidae: Cryptinae: Phygadeuontini*), reared from an indeterminable species of Yponomeutidae.

Results - Parasitoid Species Identified and Host Records

A complete listing of the parasitoid species identified in this project, including the number of host defoliator species each was reared from and the total number of rearing records for each species is presented in Table 1. Complete details for host species, rearing phenology, and collection information are available in print or electronic format from the authors. Parasitoid species reared from selected exotic defoliator species are presented in Table 2.

Table 1. Parasitoid species, classification, host and record numbers for parasitoids reared between 1994 and 1999.

Parasitoid Species	Classification	Number of Host Spp.	Total Number of Records
Apantales xanthostigma	*Braconidae: Microgastinae*	3	7
Apanteles aristoteliae	*Braconidae: Microgastinae*	3	6
Apanteles polychrosidis	*Braconidae: Microgastinae*	3	5
Apanteles sp.	*Braconidae: Microgastinae*	1	1
Apanteles sp.1	*Braconidae: Microgastinae*	1	1
Apanteles sp.3	*Braconidae: Microgastinae*	1	1
Apanteles sp.4	*Braconidae: Microgastinae*	1	1
Apanteles sp.5	*Braconidae: Microgastinae*	1	1
Apanteles sp.6	*Braconidae: Microgastinae*	1	1
Apechthis picticornis	*Ichneumonidae: Pimplinae*	1	1
Ascogaster quadridentata	*Braconidae: Cheloninae*	1	1
Campoplex sp.1	*Ichneumonidae: Campopleginae*	1	1
Campoplex sp.2	*Ichneumonidae: Campopleginae*	1	1
Charitopes n. sp.	*Ichneumonidae: Cryptinae*	1	1
Charmon cruentatus	*Braconidae: Homolobinae*	2	3
Cotesia sp.	*Braconidae: Microgastinae*	1	1
Diadegma sp. 1	*Ichneumonidae: Campopleginae*	5	21
Diadegma sp. 2	*Ichneumonidae: Campopleginae*	7	58
Diadegma sp.3	*Ichneumonidae: Campopleginae*	3	4
Diadegma sp.4	*Ichneumonidae: Campopleginae*	1	1
Diaglyptidia sp.	*Ichneumonidae: Cryptinae*	1	1
Dolichogenidia clavata	*Braconidae: Microgastinae*	2	2
Dolichogenidia longicauda	*Braconidae: Microgastinae*	2	3
Gelis sp.	*Ichneumonidae: Cryptinae*	4	7
Glypta sp.1	*Ichneumonidae: Banchinae*	3	12
Glypta sp.2	*Ichneumonidae: Banchinae*	1	4
Glypta sp.3	*Ichneumonidae: Banchinae*	1	4
Horimus radialis	*Braconidae:Horimiinae*	1	1
Hyposter sp.1	*Ichneumonidae: Campopleginae*	1	1
Hyposter sp.2	*Ichneumonidae: Campopleginae*	1	1
Ischnus inquisitorius	*Ichneumonidae: Cryptinae*	3	8
Itoplectis quadricingulata	*Ichneumonidae: Pimplinae*	7	13
Macrocentrus linearis	*Braconidae: Macrocentrinae*	1	1
Mesochorus sp.	*Braconidae: Mesochorinae*	1	2
Meteorus sp.	*Braconidae: Meteorinae*	1	2
Meteorus sp.1	*Braconidae: Meteorinae*	1	2
Meteorus sp.2	*Braconidae: Meteorinae*	1	1
Meteorus sp.3	*Braconidae: Meteorinae*	3	3
Meteorus trachynotus	*Braconidae: Meteorinae*	1	6
Microgaster epigoges	*Braconidae: Microgastinae*	4	35
Oedemopsis scabricula	*Ichneumonidae: Tryphoninae*	2	6
Oncophanes americanus	*Braconidae: Horimiinae*	2	2
Orgilus punctator	*Braconidae: Orgilinae*	1	3
Pimpla hesperus	*Ichneumonidae: Pimplinae*	1	4
Scambus hirticauda	*Ichneumonidae: Pimplinae*	1	3
Triclistus emarginalus	*Ichneumonidae: Metopiinae*	1	17

Results - Parasitoid Species Identified and Host Records (Cont.)

Table 2. Defoliator host species, reared parasitoids, and number of rearing records compiled between 1994 and 1999.

Defoliator / Host Species	Parasitoid species	Number of Records
Archips fuscocupreanus	*Apantales xanthostigma*	5
Exotic Species - Recent Find / Discovery	*Apanteles sp.3*	1
	Apanteles sp.6	1
	Campoplex sp.1	1
	Campoplex sp.2	1
	Diadegma sp.1	5
	Diadegma sp.2	20
	Diadegma sp.3	1
	Dolichogenidia clavata	1
	Gelis sp.	2
	Itoplectis quadricingulata	1
	Mesochorus sp.	2
	Meteorus sp.3	1
	Microgaster epigoges	3
	Oncophanes americanus	1
Archips rosanus	*Apantales xanthostigma*	1
Exotic Species	*Apanteles aristoteliae*	1
Long Established in N. America	*Apanteles polychrosidis*	2
	Cotesia sp.	1
	Diadegma sp.1	4
	Diadegma sp.2	12
	Dolichogenidia clavata	1
	Gelis sp.	2
	Glypta sp.1	2
	Ischnus inquisitorius	1
	Itoplectis quadricingulata	5
	Meteorus sp.2	1
	Meteorus trachynotus	1
	Microgaster epigoges	7
	Oncophanes americanus	1
Argyrotaenia franciscana	*Apanteles aristoteliae*	4
Native species	*Apanteles sp.4*	1
Choreutis pariana	*Diadegma sp.2*	12
Exotic Species - Long Established	*Dolichogenidia longicauda*	2
	Gelis sp.	2
	Triclistus emarginalus	17
Choristoneura rosaceana	*Apanteles aristoteliae*	1
Native Species	*Apanteles polychrosidis*	1
	Apanteles sp.1	1
	Charmon cruentatus	2
	Diadegma sp.1	9
	Diadegma sp.2	10
	Diadegma sp.3	1
	Glypta sp.1	9
	Glypta sp.2	4
	Glypta sp.3	4
	Horimus radialis	1
	Ischnus inquisitorius	6
	Itoplectis quadricingulata	2
	Macrocentrus linearis	1
	Meteorus sp.	2
	Meteorus sp.3	1
	Meteorus trachynotus	5
	Microgaster epigoges	24
	Oedemopsis scabricula	5
	Scambus hirticauda	3
Coleophora serratella	*Gelis sp.*	1
Exotic - Established	*Orgilus punctator*	3
Croesia holmiana	*Apanteles sp.*	1
Exotic Species - Recently Established	*Charmon cruentatus*	1
	Diadegma sp.1	1
	Diadegma sp.2	2
	Diadegma sp.3	2
	Itoplectis quadricingulata	1
	Meteorus sp.3	1
Enarmonia formosana	*Itoplectis quadricingulata*	1
Exotic - Recent	*Pimpla hesperus*	4
Pandemis heparana	*Apantales xanthostigma*	1
Exotic Species - Recently Established	*Diadegma sp.2*	1
	Dolichogenidia longicauda	1
	Itoplectis quadricingulata	1
Pandemis sp.	*Apechthis picticornis*	1
(Probably P. heparana or P. cerasana)	*Diadegma sp.1*	2
Exotic Species Recently Established	*Diadegma sp.4*	1
	Hyposter sp.1	1
	Ischnus inquisitorius	1
	Itoplectis quadricingulata	2
	Oedemopsis scabricula	1
Spilonota ocellana	*Apanteles polychrosidis*	2
Exotic Species - Long Established	*Apanteles sp.5*	1
	Ascogaster quadridentata	1
	Diadegma sp. 2	1
	Diaglyptidia sp.	1
	Meteorus sp.1	2
	Microgaster epigoges	1
Yponomeuta sp. (prob. new exotic)	*Charitopes n. sp.*	1

In the interest of providing identification resources for pest control operators and others involved in managing the impacts from defoliating pests in the Pacific Northwest, graphic images of most of the more prominent parasitoid species listed in the preceding tables are provided in the subsequent portions of this report. (See image use and distribution note at end of document) Pictured species are those identified to the species level and/or were found to be parasitizing significant economic exotic species new to the region.

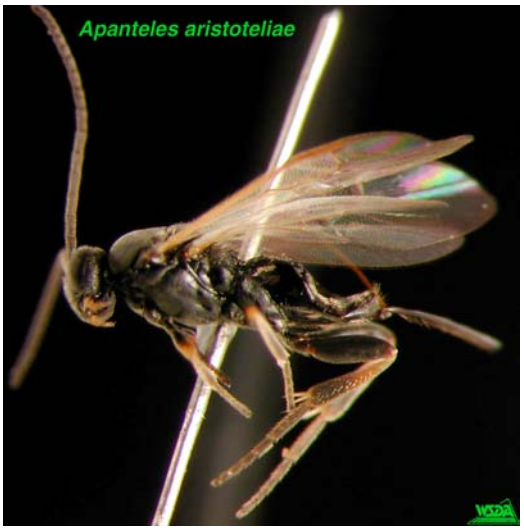
A summary of the records for defoliator larvae reared during CAPS surveys since 1994 is presented in Table 3. Note that the percent parasitism shown is provided for discussion purposes and is calculated relative to the number of total rearing records shown. For a few defoliator species the total number of rearing records shown is fairly inclusive, and the overall rate of parasitism (% Parasitism) approximates rates observed in the field (*A. rosanus, C. pariana, and C. holmiana*). However, for most species the total number of all larvae reared is not available, thus the parasitism rates shown are inflated to some degree and are not significant.

Table 3. Rearing records summary

Host	Total Rearing Records	Parasitoid Records	% Parasitism *
Archips fuscocupreanus	390	46	11.8 %
Archips rosanus	516	42	8.1 %
Argyrotaenia franciscana	7	5	71.4 %
Choreutis pariana	74	33	44.6 %
Choristoneura rosaceana	477	92	19.3 %
Coleophora serratella	9	4	44.4 %
Croesia holmiana	74	9	12.2 %
Enarmonia formosana	11	5	45.5 %
Pandemis cerasana	14	0	0.0 %
Pandemis heparana	71	4	5.6 %
Pandemis sp.	14	9	64.3 %
Spilonota ocellana	51	9	17.6 %
Yponomeuta sp. (prob.)	61	1	1.6 %

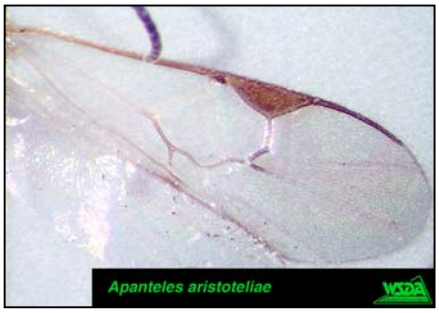
* - Not Based on Quantified Sampling

Parasitoid Species Identified and Host Records



Apanteles aristoteliae Viereck (Braconidae: Microgastrinae)

Host Species	# Records
Archips rosanus (L.) European leafroller	1
Argyrotaenia franciscana (Wlsm) orange tortrix	4
Choristoneura rosaceana (Harris) oblique-banded leafroller	1



Apanteles polychrosidis Vrk. (Braconidae: Microgastrinae)

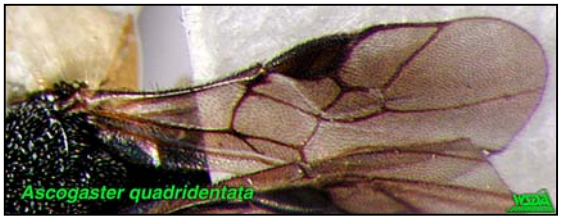
Host Species	# Records
Archips rosanus (L.) European leafroller	2
Choristoneura rosaceana (Harris) oblique-banded leafroller	1
Spilonota ocellana (Den. & Schff.) eye-spotted bud moth	2

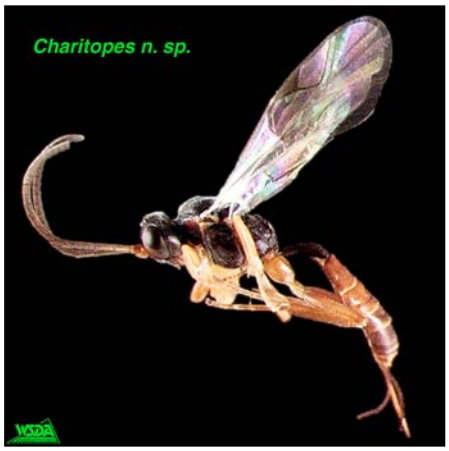
Apanteles xanthostigma Haliday (Braconidae: Microgastrinae)

Host Species	# Records
Archips fuscocupreanus Wlsm. apple tortrix	5
Archips rosanus (L.) European leafroller	1
Pandemis heparana (Dns. & Schff.) dark fruit-tree leafroller	1

Ascogaster quadridentata Wsml. (Braconidae: Cheloninae)

Host Species	# Records
Spilonota ocellana (Den. & Schff.) eye-spotted bud moth	1





Charitopes n. sp. (D. Wahl det.) (Ichneumonidae: Cryptinae)

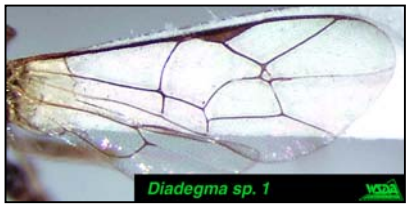
Host Species	# Records
Yponomeuta sp. (prob.)	1

Charmon cruentatus Haliday (Braconidae: Holobinae)

Host Species	# Records
Choristoneura rosaceana (Harris) oblique-banded leafroller	2
Croesia holmiana (L.) 'golden' leafroller	1

Diadegma sp. 1 (Ichneumonidae: Campopleginae)

Host Species	# Records
Archips fuscocupreanus Wlsm. apple tortrix	5
Archips rosanus (L.) European leafroller	4
Choristoneura rosaceana (Harris) oblique-banded leafroller	9
Croesia holmiana (L.) 'golden' leafroller	1
Pandemis sp.	2



Diadegma sp. 2 (Ichneumonidae: Campopleginae)

Host Species	# Records
Archips fuscocupreanus Wlsm. apple tortrix	20
Archips rosanus (L.) European leafroller	12
Choristoneura rosaceana (Harris) oblique-banded leafroller	10
Choreutis pariana apple and thorn skeletonizer	12
Croesia holmiana (L.) 'golden' leafroller	2
Pandemis heparana (Dns. & Schff.). dark fruit-tree tortrix	2
Spilonota ocellana (Dns. & Schff.) eye-spotted bud moth	2

Diadegma sp. 3 (Ichneumonidae: Campopleginae)

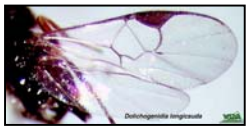
Host Species	# Records
Archips fuscocupreanus Wlsm. apple tortrix	1
Choristoneura rosaceana (Harris) oblique-banded leafroller	1
Croesia holmiana (L.) 'golden' leafroller	2

Dolichogenidea clavata (Prov.) (Braconidae: Microgastinae)

Host Species	# Records
Archips fuscocupreanus Wlsm. apple tortrix	1
Archips rosanus (L.) European leafroller	1

Dolichogenidea longicauda (Wes.)(Braconidae: Microgastinae)

Host Species	# Records
Choreutis pariana (Clerck) apple and thorn skeletonizer	2
Pandemis heparana (Dns. & Schff.). dark fruit-tree tortrix	1

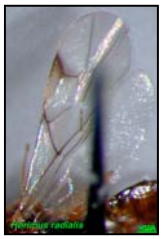


Gelis sp. (Ichneumonidae: Cryptinae) Note: a Hyperparasitoid

Host Species	# Records
Archips fuscocupreanus Wlsm. apple tortrix	2
Archips rosanus (L.) European leafroller	2
Choreutis pariana (Clerck) apple and thorn skeletonizer	2
Coleophora seratella (L.). cigar case-bearer	1

Hormius radialis Telenga (Braconidae: Hormiinae)

Note: First Record for North American (a European species)



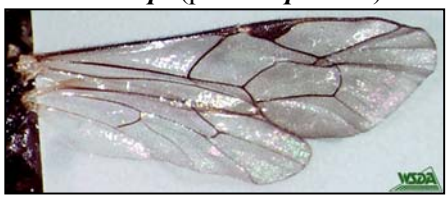
Host Species	# Records
Choristoneura rosaceana (Harris) oblique-banded leafroller	1

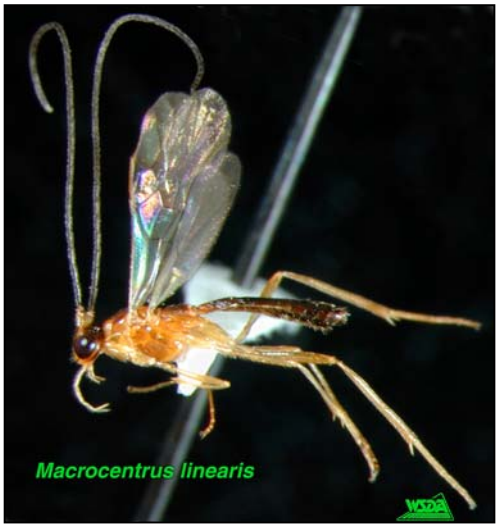
Ischnus inquisitorius (Muller) (Ichneumonidae: Cryptinae)

Host Species	# Records
Archips rosanus (L.) European leafroller	1
Choristoneura rosaceana (Harris) oblique-banded leafroller	6
Pandemis sp. (prob. ***heparana***) dark fruit-tree leafroller	1

Itoplectis quadricingulata (Prov.) (Ichneumonidae:Pimplinae)

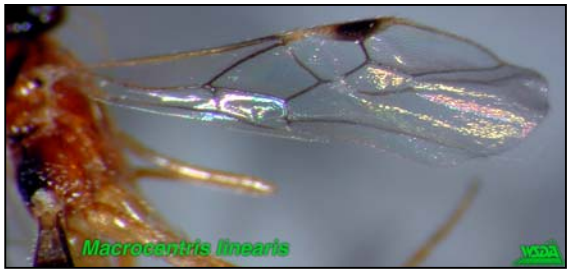
Host Species	# Records
Archips fuscocupreanus Wlsm. apple tortrix	1
Archips rosanus (L.) European leafroller	5
Choristoneura rosaceana (Harris) oblique-banded leafroller	2
Croesia holmiana (L.) 'golden' leafroller	1
Enarmonia formosana (Scop.) cherry bark tortrix	1
Pandemis heparana (Dns. & Scff.) dark fruit-tree tortrix	1
Pandemis sp. (prob. ***heparana***)	2





Macrocentrus linearis (Nees) (Braconidae: Macrocentrinae)

Host Species	# Records
Choristoneura rosaceana (Harris) oblique-banded leafroller	1



Meteorus trachynotus Viereck (Braconidae: Meteorinae)

Host Species	# Records
Archips rosanus (L.) European leafroller	1
Choristoneura rosaceana (Harris) oblique-banded leafroller	5

Microgaster epigoges Gahan (Braconidae: Microgastrinae)

Host Species	# Records
Archips fuscocupreanus Wlsm. apple tortrix	3
Archips rosanus (L.) European leafroller	7
Choristoneura rosaceana (Harris) oblique-banded leafroller	24
Spilonota ocellana (Denis & Schff.) eye-spotted bud moth	1

Oedemopsis scabricula Gravenhorst (Ichneumonidae: Tryphoninae)

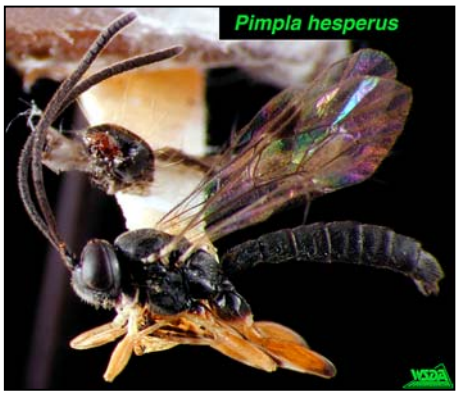
Host Species	# Records
Choristoneura rosaceana (Harris) oblique-banded leafroller	5
Pandemis sp. (prob ***heparana)***	1

Oncophanes americanus (Weed) (Braconidae: Hormiinae)

Host Species	# Records
Archips fuscocupreanus Wlsm. apple tortrix	1
Archips rosanus (L.) European leafroller	1

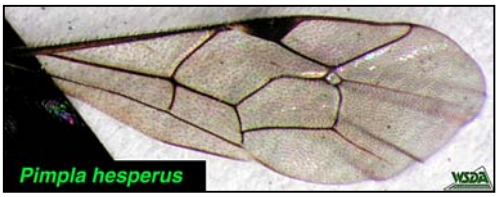
Ogilus punctator (Nees) (Braconidae: Orgilinae)

Host Species	# Records
Coleophora serratella (L.) cigar case-bearer	3



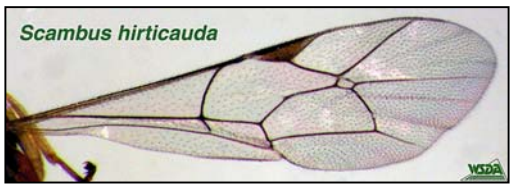
Pimpla hesperus Townes (Ichneumonidae: Pimplinae)

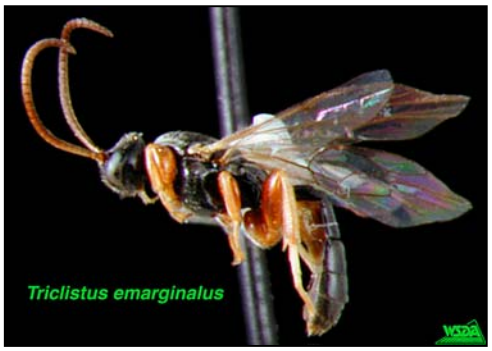
Host Species	# Records
Enarmonia formosana (Scopoli) cherry bark tortrix	4



Scambus hirticauda Provancher (Ichneumonidae: Pimplinae)

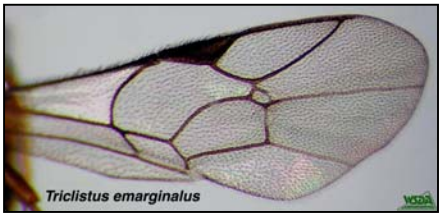
Host Species	# Records
Choristoneura rosaceana (Harris) oblique-banded leafroller	3





Triclistus emarginalus Say (Ichneumonidae: Metopiinae)

Host Species	# Records
Choreutis pariana Clerck apple and thorn skeletonizer	17



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